StocMod12 Paris

Program

Ecole Centrale Paris
Chatenay-Malabry, France
May 30th, 31th & June 1st 2012

CENTRALE PARIS

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Prologue

We welcome you at Ecole Centrale Paris for StochMod12.

This meeting is the fourth in a series aiming to promote research and encourage interaction in the working group of stochastic modeling. The first meeting of the EURO Working Group on Stochastic Modeling was held from 19th April until 21st April 2006 at the Department of Mathematics at VU University Amsterdam, The Netherlands. The second meeting was held from 23rd June until 25th June 2008 at Koç University in Istanbul, Turkey. The third meeting was held from 7th June until 9th June 2010 by the department of Mathematics at University of Athens in Nafplio, Greece.

Stochastic modeling is an active research field with much interaction between theory and practice. Up to now there was no platform for European researchers working within this broad field. This explains the idea for a European Working Group on Stochastic modeling. In June 2004 this was first proposed to EURO, the Association of European Operational Research Societies. The Working Group is concerned with all aspects, both theoretical and practical, of mathematical modeling using stochastic models. The areas of interest include, but are not restricted to performance analysis of telecommunication systems, the modeling of logistics and service systems, the theory of queueing and inventory models, revenue management, stochastic models in finance and more.

The meeting brings together 71 participants from 18 countries. We would like to express our appreciation to all participants for contributing and presenting their work. We also thank Ecole Centrale Paris for economic and administrative support.

Châtenay-Malabry, May 30th, 2012

Oualid Jouini

Scientific Program Committee

Zeynep Aksin, Koç University, Turkey
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Local Program Committee

Sylvie Guillemain
Delphine Martin
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General Information

Dates
May 30th - June 1st, 2012.

Organized by
Laboratoire Génie Industriel, Ecole Centrale Paris.

Conference Venue
Ecole Centrale Paris, Olivier building
Grande Voie des Vignes, Châtenay-Malabry, France.

Website
http://www.lgi.ecp.fr/StochMod2012/pmwiki.php

Welcome reception
In Olivier building, on Wednesday May 30th, 8:30-9:30am.

Social Program
The conference diner will take place on the second day of StochMod12 (Thursday May 31, 2012). It is a diner cruise on La Seine river provided by the company Capitaine Fracasse. The price is already included in your registration fee. We will take the bus at 6:00pm (from the main entrance of Ecole Centrale Paris) to go there. The boarding is at 9:00pm. We then have some free time (about 1h30) before boarding.

Access to the boat: The access to the boat restaurant is located in Paris (15th district) on Ile aux Cygnes, accessible from the bridge of Bir Hakeim, near 'Bir Hakeim' metro 6 station, or 'Champs de Mars-Tour Eiffel' RER C train station. The boarding port is Ile aux Cygnes. It is downstairs from the middle of the bridge of Bir Hakeim.

StocMod12 Program

Wednesday May 30th			
	8:30 - 9:30	Welcome reception - Coffee break	
	9:30 - 10:00	**Conference opening - Amphi 1**	
	10:00 - 11:00	**Plenary talk - Amphi 1** François Bacelli, *INRIA-ENS* Stochastic Geometry and Wireless Network Modeling	
	11:00 - 12:30	**Session W1 - Amphi 1** 1. Wim Van Ackooij and Michel Minoux *Robust Models for Hydro Reservoir Management in Unit Commitment problems* 2. Shuangqing Liao, Christian van Delft and Jean-Philippe Vial *Distributionally robust workforce scheduling in call centers* 3. Kimmo Nurmi, Nico Kyngäs and Juho Salli *A workload prediction, staffing and shift generation method for contact centers*	**Session W2 - Amphi 7** 1. Bernard Lamond *Dynamic models and control policies for stochastic control of a machine tool* 2. Burak Buke and Hanyi Chen *Stabilizing Policies for Matching Portals* 3. Fikri Karaesmen and Can Öz *A Robust Decision Making Approach to the Optimal Stopping Problem* 4. Dimitrios Pandelis *Optimal control of a flexible server in two-stage tandem queueing systems*
	12:30 - 14:00	**Lunch**	
	14:00 - 15:30	**Session W3 - Amphi 1** 1. Alex Roubos, Rene Bekker and Sandjai Bhulai *Service level distribution of single- and multi-server queues* 2. Pedram Sahba, Baris Balcioglu and Dragan Banjevic *Analysis of the Finite-source Multi-class Priority Queue with an Unreliable Server and Setup Time* 3. Maartje van de Vrugt, Nelly Litvak and Richard J. Boucherie *Advance resource reservation in Erlang Loss queues* 4. Fazia Rahmoune-Aoudia and Djamil Aissani *A Taylor Series Approach to the Numerical Analysis of the M/G/1//N Queue with Multiple Vacation of the Server*	**Session W4 - Amphi 7** 1. Laurens Smit and Michael Katehakis *On Computing Optimal (Q,r) Replenishment Policies under Quantity Discounts* 2. Samuel Vercraene, Jean-Philippe Gayon and Simme Douwe Flapper *Coordination of manufacturing, remanufacturing and returns acceptance in a hybrid production-inventory system* 3. Sachin Jayaswal, Elizabeth Jewkes and Saibal Ray *Product Differentiation and Operations Strategy in a Capacitated Environment* 4. Alejandro Lamas and Philippe Chevalier *Horizontal collaboration without transfer payments : defining operational rules to hedge uncertainty*
	15:30 - 16:00	**Coffee break**	
	16:00 - 17:30	**Session W5 - Amphi 1** 1. E. Lerzan Ormeci, Hessam Bavafa and Savin Sergei *Optimal Mix of Surgical Procedures Under Stochastic Patient Length of Stay* 2. Xiaolan Xie and Na Geng *Contract and Advance Cancellation of MRI Time Slots for Stroke Patients* 3. Yiannis Dimitrakopoulos and Lerzan Ormeci *Equilibrium behavior of patients served by a dual practice physician* 4. Burhaneddin Sandikci, Lisa Maillart, Andrew Schaefer and Mark Roberts *Modeling the transplant waiting list for liver acceptance decisions*	**Session W6 - Amphi 7** 1. Stella Kapodistria, Ivo Adan and Johan van Leeuwaarden *Erlang arrivals joining the shortest queue* 2. Berdjoudj Louiza and Aïssani Djamil *Analysis of GI/M/1 retrial queue with negative arrivals* 3. Herman Blok, Flora Spieksma and Sandjai Bhulai *K competing queues with customer impatience: optimality of the mu-c rule by the Smoothed Rate Truncation principle* 4. Nawel Arrar, Natalia Djellab and Jean-Bernard Baillon *Description of the orbiting customers for the retrial queue with impatient batches*

Thursday May 31th

9:00 - 10:00	**Plenary talk - Amphi 1** Rhonda Righter, *UC Berkley* Using Individuals to Understand System Optima
10:00-10:30	**Coffee break**

10:30 - 12:30	**Session T1 - Amphi 1**	**Session T2 - Amphi 7**
	1. Takashi Matsuhisa *Communication leading to Coalition Nash equilibrium* 2. Olga Boudali and Antonis Economou *Strategic Behavior In The Single Server Markovian Queue with Catastrophes: To Avoid or Follow the Crowd?* 3. Apostolos Burnetas *Equilibrium Strategies in Exercising Multiple Options for Expedited Service* 4. Görkem Sarıyer, Fikri Karaesmen and Zeynep Aksin *Quality Conscious Strategic Customers in Queues* 5. Antonis Economou and Athanasia Manou *Strategic customer behavior in a transportation station*	1. Naoto Miyoshi and Tomoyuki Shirai *A cellular network model with Ginibre configurated base stations* 2. Hiroshi Toyoizumi *Fluid Limit of Spread on Network* 3. Fumio Ishizaki *Studies on the properties of short term fairness provided by one-bit feedback fair scheduler* 4. Konstantin Avrachenkov, Urtzi Ayesta, Josu Doncel and Peter Jacko *Congestion Control of Flows in Internet Routers by Means of Index Policies* 5. Devin Sezer and Mine Caglar *Diffusion Limit for an Epidemic Information Dissemination Algorithm*

12:30 - 14:00	**Lunch**

14:00 - 15:30	**Session T3 - Amphi 1**	**Session T4 - Amphi 7**
	1. Efstratios Ioannidis *Joint Production and Order Admission Control in Two Stage Production Lines with Intermediate Product Demand* 2. Felix Papier *Energy management in make-to-stock manufacturing lines with backordering* 3. Tanja Mlinar and Philippe Chevalier *Exploring economies of scale for MTO production systems under lead time sensitive demand* 4. Alejandro Lamas, Tanja Mlinar, Liang Lu and Philippe Chevalier *Order Acceptance for Two Classes of Demand with Heterogeneous Lead Time*	1. Yuanyuan Liu *Perturbation bounds for the stationary distributions of Markov chains* 2. Niek Baer, Richard J. Boucherie and Jan-Kees van Ommeren *The PH/PH/1 threshold queue - An application in highway traffic.* 3. George Mytalas and Michael Zazanis *Reliability of a two class k-out-of-n system with repair* 4. Ad Ridder, Reuven Rubinstein and Radislav Vaisman *Splitting Methods for Model Counting*

15:30 - 16:00	**Coffee break**

16:00 - 17:30	**Session T5 - Amphi 1**	**Session T6 - Amphi 7**
	1. Ger Koole, Wyean Chan and Pierre L'Ecuyer *Call Center Routing Policy Using Call Waiting and Agent Idle Times* 2. Benjamin Legros, Oualid Jouini, Yves Dallery and Ger Koole *Managing operations in a multichannel call center* 3. Zeynep Aksin, Baris Ata, Seyed Emadi and Che-Lin Su *Structural Estimation of Callers' Delay Sensitivity in Call Centers*	1. Yanfu Li, Yanhui Lin and Enrico Zio *Stochastic Modeling by Inhomogeneous Continuous Time Markov Chains* 2. Jeremy Large and Thomas Norman *Markov Perfect Bayesian Equilibrium via Ergodicity* 3. Maria Rieders, Lerzan Ormeci, Esma Gel and A. Baykal Hafizoglu *Arrival Processes Based on SIR Models for Epidemic Diseases* 4. Mahdi Fathi *On the use of phase type distributions for modeling of trust relationships*

18:00	**Gala Dinner** (departure from the main entrance of Ecole Centrale Paris)

	Friday June 1st	
Friday May 1st	9:00 - 10:00	**Plenary talk - Amphi 1** Refael Hassin, *Tel Aviv University* Rational Queueing
	10:00-10:30	**Coffee break**
	10:30 - 12:30	**Session F1 - Amphi 1** 1. Chu-Ti Lin, Yan-Fu Li and Cheng-Ding Chen *A Rate-Based Queueing Simulation Model of Open Source Software Debugging Activities* 2. Rodrigo Mena, Enrico Zio, Pablo Viveros, Fredy Kristjanpoller and Adolfo Arata *Stochastic Modeling and Simulation of an Open-Pit Mine Truck-Shovel System* 3. Philippe Chevalier and Wen Li Peng *Simulating the impact of order smoothing on the performance of a supply chain with volatile demand and restrictive capacity* 4. Sophie Weiss and Raik Stolletz *Buffer allocation in stochastic flow lines using sampling approaches* 5. Roberto Szechtman and Enver Yucesan *A New Perspective on Feasibility Determination*
	12:30 - 14:00	**Lunch**
	14:00 - 15:30	**Session F2 - Amphi 1** 1. Pelin Canbolat *Markov population decision chains with constant risk posture* 2. Alex Roubos, Sandjai Bhulai and Ger Koole *Flexible staffing for call centers with non-stationary arrival rates* 3. Alexandre Salch, Jean-Philippe Gayon and Pierre Lemaire *Dynamic control of a multi class G/M/1+M queue with abandonments* 4. Erim Kardes *On Markov Decision Processes with Chance Constraints*
	15:30	**End of conference**

Wednesday May 30th

8:30 - 9:30

Welcome Reception and Coffee break (Main entrance of Olivier Building)

9:30 - 10:00- Amphi 1

Conference Opening

10:00 - 11:00 - Amphi 1

Plenary talk

François Baccelli, Ecole Normale Supérieure Paris / INRIA, France.

Stochastic Geometry and Wireless Network Modeling.

The geometry of the location of mobiles and/or base stations plays a key role in several classes of wireless communication networks where it determines the signal to interference ratio for each potential channel and hence the possibility of establishing simultaneously some set of communications at a given bit rate.
Stochastic geometry provides a natural way of defining (and computing) macroscopic properties of such networks, by some averaging over all potential geometrical patterns for e.g. the mobiles.
The talk will survey recent results obtained by this approach for analyzing key properties of wireless networks such as coverage in cellular networks or connectivity in mobile ad hoc networks, and for evaluating the performance of a variety of protocols used in this context such as medium access control or routing.

11:00 - 12:30 Sessions W1 and W2 in parallel

Session W1 - Amphi 1

Robust Models for Hydro Reservoir Management in Unit Commitment problems.

Wim Van Ackooij, wim.van-ackooij@edf.fr, EDF R&D / Ecole Centrale Paris, France.
Michel Minoux, minouxm@poleia.lip6.fr, Université Paris 6, France.

In energy management, the so-called unit commitment problem aims at finding the least cost production schedule, while satisfying a large set of operational constraints. These are typically large scale, non-convex and even combinatorial problems. For this reason, they are often considered in a deterministic setting. However, in order to come up with more realistic models, uncertainty has to be taken into account (typical sources of uncertainty are water supplies, or customer power requirements). Adding uncertainty to the unit-commitment problem gives rise to stochastic linear programs, possibly featuring right-hand side uncertainty or constraint matrix uncertainty. In this work we propose several robust models for the hydro sub-problem, in which only the right-handside is subject to uncertainty. We discuss the convexity of the feasible set, provide solution algorithms and finally discuss computational results obtained on a set of realistic examples. In particular, it is shown that neglecting uncertainty leads to almost sure violation of the constraints and that robustness can anyway be obtained at limited additional cost.

Keywords: Unit commitment, hydro reservoir management, robust optimization, joint chance constraints.

Distributionally robust workforce scheduling in call centers.

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Jean-Philippe Vial, jphvial@bluewin.ch, Ordecsys, Switzerland.

Call center scheduling aims to determine the workforce so as to meet target service levels. The service level depends on the mean rate of arrival calls, which uctuates during the day and the day and from day to day. The sta schedule must workforce period per period during the day, but the exibility exibility in doing so is limited by the workforce shifts. The challenge is to balance salary costs and possible failures to meet service levels. In this paper, we consider uncertain arrival rates, that vary according to an intra-day seasonality and a global busyness factor. Both factors (seasonal and global) are estimated from past data and are subject to errors. We propose an approach combining stochastic programming and distributionally robust optimization to minimize the total salary costs under service level constraints. The performance of the robust solution is simulated via Monte-Carlo techniques and compared to the solution based on pure stochastic programming.
Keywords: Call centers, uncertain arrival rates, robust optimization, ambiguity, staff-scheduling, totally unimodular.

A Workload Prediction, Staffing and Shift Generation Method for Contact Centers.

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Nico Kyngäs, nico.kyngas@samk.fi, Satakunta University of Applied Sciences, Finland.
Juho Salli, juho.salli@student.samk.fi, Satakunta University of Applied Sciences, Finland.

This is a multidisciplinary study of stochastic modeling and computational optimization. We have previously solved real-world days-off scheduling and staff rostering problems. Recently our research has focused on shift generation. However, there is no use of optimizing the shifts if the number of staff required in each time slot is not reasonably generated. We faced this problem with our business partner. Their customers were not able to translate the amount of work into numbers of required agents so as to meet the target service level. These customers were multi-skill contact centers with various back-office jobs such as answering emails. We present a robust method which is capable of 1) forecasting the number of staff, 2) generating the shift structure for the staff and 3) assigning the employees to the shifts. The proposed approach is evaluated with real-world data from Finnish contact centers. Computational results and customer feedback show that our method produces customer-optimal solutions.
Keywords: Staffing, shift generation, contact Centers.

11:00 - 12:30 Sessions W1 and W2 in parallel

Session W2 - Amphi 7

Dynamic models and control policies for stochastic control of a machine tool.

Bernard Lamond, bernard.lamond@fsa.ulaval.ca, Universite Laval, Canada.

We discuss a dynamic programming model of a machine tool with stochastic tool life and we analyze the structure of a simplified decision rule with same cutting speed for all subsequent tools. Under suitable regularity conditions, the simplified decision rule has a finite number of critical points that are easily computed from the renewal function of the tool life distribution. Moreover, numerical results suggest that the simplified decision rule can be used to closely approximate the optimal policy of the stochastic DP model and its expected value function.
Keywords: Stochastic dynamic programming.

Stabilizing Policies for Matching Portals.

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Hanyi Chen, H.Chen-29@sms.ed.ac.uk, University of Edinburgh, United Kingdom.

In recent years, it has become widely accepted in the society to use internet for business and personal interactions. For this purpose, the portals, which match the people who provide a specific service with the people who demand the service, are becoming increasingly popular. In this talk, we mainly concentrate on employment portals, where the employers and employees are assumed to arrive with respect to independent Poisson processes with rate λ_1 and λ_2 respectively. Each given employee can match with a specific employer with probability q independent of other employees and employers. With the arrival rate and the matching probability, we model this system as a two-dimensional continuous time Markov chain and analyze its properties. Our main focus is on stabilizing policies for such portals.
To consider the stability of the system, we will first consider the case when the matching probability $q=1$, as it can be simplified to an one-dimensional birth-death process, which is well-known that the system is null-recurrent when the arrival rates $\lambda_1=\lambda_2$ and transient when $\lambda_1 \neq \lambda_2$. For the case when $0 < q < 1$, we will prove that the same conclusion as the case of $q=1$ holds that it is transience for $\lambda_1 \neq \lambda_2$ and null recurrence for $\lambda_1=\lambda_2$.
Next, we will introduce the Accept the Shortest Queue (ASQ) policy, which accepts employees(employers) only when they have a smaller or equal number than employers(employees). Under this policy, the system will be ergodic for any set of arrival rates. Since the rate of rejecting customers by this policy is exceptionally large, we consider how this system can be modified to enable us to accept more customers without losing stability.
Keywords: Stability, matching, admission control.

A Robust Decision Making Approach to the Optimal Stopping Problem.

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The optimal stopping problem in stochastic control has many interesting applications in Operations Research such as finding the optimal time to sell an asset or to hire an employee. The structure of the optimal policy for this problem depends on the offer distribution characteristics. For time invariant and independent offer distributions, the optimal policy is a threshold policy where every new offer is compared with that period's threshold and is accepted if it is greater, otherwise it is rejected. This level depends on the offer distribution which is assumed to be fully known. In our study, by relaxing the assumption that the offer distribution is fully known, the distribution free robust problem is analyzed. For both the stationary and the non-stationary versions of the problem, robust optimal policies are characterized via dynamic programming. The performance of the robust solution in comparison to the existing nominal solution is assessed through numerical examples.
Keywords: Optimal stopping, dynamic programming, robustness.

Optimal control of a flexible server in two-stage tandem queueing systems.

Dimitrios Pandelis, d_pandelis@mie.uth.gr, University of Thessaly, Greece.

We consider two-stage tandem queueing systems with a dedicated server in each queue and a flexible server that can serve in both queues. Service times are exponentially distributed and linear holding costs are incurred by the jobs during the time they remain in the system. Clearing systems of this type have been studied in the literature. Under the assumption that servers do not idle and that two servers can collaborate to work on the same job with additive service rate, it has been shown that the optimal allocation strategy for the flexible server is characterized by a switching curve. In the present work we attempt to derive structural properties of the optimal strategy with the aforementioned assumptions relaxed.
Keywords: Tandem queues, flexible servers, Markov decision processes, dynamic programming.

12:30 - 14:00

Lunch

14:00 - 15:30 Sessions W3 and W4 in parallel

Session W3 - Amphi 1

Service level distribution of single- and multi-server queues.

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Service levels or the fractions of customers waiting at most some threshold value are common performance measures in service systems, as in call centers. A steady-state analysis may provide a long-run average service level, i.e. a single number, but neglects the variations on shorter time scales. In practice, such short time scale variations are important as the performance is usually judged based on periods of finite length. The aim of this talk is to give insight in the service level distribution over such finite intervals.
In particular, we consider M/M/1 and M/M/s queues. We mainly focus on the time average version of the service level, that is the fraction of time that the virtual waiting time process is at or below some threshold value (occupation time). Using alternating renewal processes, Laplace transforms and some fluctuation identities we derive the transform of the occupation time over an interval of fixed length. Results show that these variations are non-negligible and that a normal approximation is not always accurate on short (but realistic) time scales. As the interval length increases, the service level converges to a normal distribution. We also shed light on the variance in this limiting case.
Keywords: call center, service level, finite interval, occupation time, Laplace transform.

Analysis of the Finite-source Multi-class Priority Queue with an Unreliable Server and Setup Time.

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Dragan Banjevic, banjev@mie.utoronto.ca, University of Toronto, Canada.

We study a queueing system serving multiple classes of customers with an unreliable server. Each class is a finite-calling population. The server is subject to operation-independent disruptions and requires a setup time before resuming interrupted service or picking up a new customer. We analyze the busy period in this queueing system, and derive the steady-state system size distributions at departure/arrival, and arbitrary time epochs. We introduce the residual augmented process system to obtain the system time distribution. Our numerical analysis reveals the importance of incorporating the distributions of the service and server interruption/down times into the model, since their impact on customer service levels could be counterintuitive. For instance, higher service time variability in certain instances shortens the mean queue lengths. We also study the single-class M/G/1//N queue where the server is subject to operation-dependent disruptions.
Keywords: Server disruptions, operation-independent disruptions, operation-dependent disruptions, process completion time, busy period analysis.

Advance resource reservation in Erlang Loss queues.

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We consider a M/G/c/c queue in which resources can be claimed a random time in advance. This type of queueing systems can for example be used for modeling telecommunication systems with advance reservation possibilities. We compare the blocking probability of the reservation model with the ordinary M/G/c/c queue and show advance reservation can both in- and decrease the blocking probability. The consequences of advance reservation appear to be highly sensitive to the system parameters. We illustrate this by several examples obtained from an extensive simulation study.
Keywords: Loss queues, advance reservation, service discipline.

A Taylor Series Approach to the Numerical Analysis of the M/G/1//N Queue with Multiple Vacation of the Server.

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In this paper, we develop a functional quantitative approximation to analyze the M/G/1//N queue with multiple vacation of the server built on a Taylor series expansion and show the interest to establish the performances measurements of this system via the considered method when it is controlled by a finite discret Markov Chain. Numerical examples are carried out to illustrate the performance of our approach.
Keywords: Taylor series, approximation, numerical analysis, M/G/1//N queue with server vacation.

14:00 - 15:30 Sessions W3 and W4 in parallel

Session W4 - Amphi 7

On Computing Optimal (Q,r) Replenishment Policies under Quantity Discounts.

Laurens Smit, laurens@pipe.nl, Leiden University, The Netherlands.
Michael Katehakis, mnk@rutgers.edu, Rutgers Business School- Newark and New Brunswick, USA.

We study the classical reorder quantity, order point (Q,r) continuous review stochastic inventory model with Poisson arrivals and a fixed lead time. This model has been extensively studied in the literature and its use in practice is widespread. Our work extends previous research in this area by providing efficient algorithms for the computation of the optimal (Q*,r*) values when there is a multi-breakpoint discount pricing structure.
Keywords: Inventory production, lot sizing, backorders, quantity discounts.

Coordination of manufacturing, remanufacturing and returns acceptance in a hybrid production-inventory system.

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We study the coordination of manufacturing, remanufacturing and returns acceptance in a hybrid system. We use a queueing control framework, where manufacturing and remanufacturing are modelled by single servers with exponentially distributed processing times. Customer demands and returned products arrive in the system according to independent Poisson processes. A returned product can be either rejected or accepted. When accepted, a return is placed in a remanufacturable inventory. New products and remanufactured products are placed in a serviceable inventory and customer demands can be satisfied by new products or remanufactured ones. When the cost structure includes holding, backorder, manufacturing, admission and rejecting costs, we show that the optimal policy is characterized by two state-dependent base-stock thresholds and one state-dependent acceptance threshold. We also obtain monotonicity results for these switching curves. Then we adapt several heuristic policies from the literature to our model. Finally we carry out a numerical study to compare their performances to the ones of the optimal policy.
Keywords: Remanufacturing, inventory control, queueing control.

Product Differentiation and Operations Strategy in a Capacitated Environment.

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We study a market comprising heterogeneous customers who differ in their preferences for time and price. Time sensitive customers are willing to pay a price premium for a shorter delivery time, while price sensitive

customers are willing to accept a longer delivery time in return for a lower price. Firms exploit this heterogeneity in customers' preferences, and offer a menu of products/services that differ only in their guaranteed delivery times and prices. From demand perspective, when customers are allowed to self-select according to their preferences, different products act as substitutes, affecting each other's demand. Customized product for each segment, on the other hand, results in independent demand for each product. On the supply side, a firm may either share the same processing capacity to serve the two market segments, or may dedicate capacity for each segment. Our objective is to understand the interaction between product substitution and the firm's operations strategy (dedicated versus shared capacity), and how they shape the optimal product differentiation strategy. To address the above issue, we study this problem for a single monopolist firm, which offers two versions of the same basic product: (i) regular product at a lower price but with a longer delivery time, and (ii) express product at a higher price but with a shorter delivery time. Demand for each product arrives according to a Poisson process with a rate that depends both on its price and delivery time. In addition, if the products are substitutable, each product's demand is also influenced by the price and delivery time of the other product. Demands within each category are served on a first-come-first-serve basis. However, customers for express product are always given priority over the other category when they are served using shared resources. There is a standard delivery time for the regular product, and the firm's objective is to appropriately price the two products and select the express delivery time so as to maximize its profit rate. The firm simultaneously needs to decide its installed processing capacity so as to meet its promised delivery times with a high degree of reliability. While the problem in a dedicated capacity setting is solved analytically, the same becomes very challenging in a shared capacity setting, especially in the absence of an analytical characterization of the delivery time distribution of regular customers in a priority queue. We develop a solution algorithm, using matrix geometric method in a cutting plane framework, to solve the problem numerically in a shared capacity setting. Our study shows that in a highly capacitated system, if the firm decides to move from a dedicated to a shared capacity setting, it will need to offer more differentiated products, whether the products are substitutable or not. In contrast, when customers are allowed to self-select, such that independent products become substitutable, a more homogeneous pricing scheme results. However, the effect of substitution on optimal delivery time differentiation depends on the firm's capacity strategy and cost, as well as market characteristics. The optimal response to any change in capacity cost also depends on the firm's operations strategy. In a dedicated capacity scenario, the optimal response to an increase in capacity cost is always to offer more homogeneous prices and delivery times. In a shared capacity setting, it is again optimal to quote more homogeneous delivery times, but increase or decrease the price differentiation depending on whether the status-quo capacity cost is high or low, respectively.

Keywords: Priority queue, matrix geometric method, cutting plane, pricing, product differentiation, delivery time guarantee, product substitution, capacity sharing.

Horizontal collaboration without transfer payments : defining operational rules to hedge uncertainty.

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We address the problem of the production plan of two agents under a horizontal collaboration over a rolling planning horizon. Both agents have a fixed production capacity, which can be shared in order to satisfy the demand of their customers during each discrete production period. The demand faced by each agent is unknown before the collaborative agreement. If the global cost is minimized, the solution of the problem could establish a production plan which implies unsatisfactory results for one of the agents, e.g. individual performance worse than in the stand alone case, disparities in the results, results with high variability, etc. Then, the problem is to decide operationally how to make the production plan when the demand gets to be known such as to share the savings of the collaboration in a mutually agreeable way. In order to obtain satisfactory results, the problem has been studied in the past by defining a contract among agents that establishes transfer payments between them in order to keep the global optimality of the system ensuring that each agent is not hurt by the collaboration. However, it has been observed that such contracts are not easy to put in place in practice. We propose a novel approach in order to balance the relationship based on operational decisions. The goal is to find the best trade-off between: a global performance, limited dis-

parities between the operational results of each agent, and low variability of the results. Finally, we show by numerical experiments how our proposed approach deals with this trade-off, and we analyze the conditions under which such approach would bring most benefits for different joint production problems.
Keywords: Supply chain collaboration, cost sharing, lot sizing problem.

15:30 - 16:00
Coffee Break

16:00 - 17:30 Sessions W5 and W6 in parallel

Session W5 - Amphi 1

Optimal Mix of Surgical Procedures Under Stochastic Patient Length of Stay.
Lerzan Ormeci, lormeci@ku.edu.tr, Koç University, Turkey.
Hessam Bavafa, bavafa@wharton.upenn.edu, The Wharton School University of Pennsylvania, USA.
Savin Sergei, savin@wharton.upenn.edu, The Wharton School University of Pennsylvania, USA.

We provide analytical insights on how to optimally allocate hospital operating capacity between various types of elective surgical procedures. Our focus is on the interaction between utilizing hospital beds and operating room capacity which are the major constraining resources. In our model, each procedure type has an associated revenue, deterministic case duration, and stochastic length of stay. Length of stay of a patient is the number of days it takes for the patient to recover and leave the hospital, where we consider arbitrary distributions for length of stay. In this setting, the surgeries performed "today" affect the availability of hospital beds for the following days. We describe the optimal mix of procedures in the presence of a service-level constraint on hospital beds, an operating room capacity constraint, and procedure demand constraints.
Keywords: Stochastic length of stay, optimal mix of surgical procedures, health care.

Contract and Advance Cancellation of MRI Time Slots for Stroke Patients.
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Na Geng, gengna@sjtu.edu.cn, Shanghai Jiao Tong University, China.

This paper addresses the design of contract-based solutions for MRI (Magnetic resonance imaging) examinations for stroke patients treated in a neurovascular department. A contract-based solution is characterized by: contracted time slots (CTS) reserved by the imaging department for the neurovascular department, advance cancellation of contracted time slots, and requests for regular time slots (RTS). The problem of CTS cancellation and RTS assignment is formulated as an average cost Markov Decision Process in order to minimize costs incurred by patient waiting times, unused CTS and CTS cancellation. Structural properties of the optimal control policies are established. Numerical results show that advance CTS cancellation significantly reduces the ratio of unused CTS with slight increase of patient waiting time.
Keywords: MRI planning, contract, advance cancellation, Markov decision process, local optimization

Equilibrium behavior of patients served by a dual practice physician.
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Lerzan Ormeci, lormeci@ku.edu.tr, Koç University, Turkey.

We analyze the problem of equilibrium behavior for patients who can decide to be treated either in the public or in the private sector by the same moonlighter physician who is a profit maximizer. We consider two classes of patients who arrive independently according to Poisson processes with different rates at a system. The system consists of two parallel M/M/1 queues, one representing a public health care facility and the other the moonlighter's private practice. The physician serves both queues with the same exponential rate, and he alternates service between public and private practice also with exponential rates. Every patient who joins the first queue receives a reward for being treated and incurs a cost rate per unit time of

delay, whereas joining the second queue incurs an additional instant cost, which represents the physician's fee. The decision for first class patients is always to join the first queue, whereas a second class patient decides which queue he will join upon his arrival, in order to maximize his expected net benefit without observing the current queue length. We identify the equilibrium strategies of second class patients and we derive the physician's revenue maximizing pricing policy from private practice. In addition, we analyze the corresponding decision problem of health authorities comparing several health care policies that prohibit or allow physician's moonlighting behavior with or without limitations in order to improve the corresponding quality of medical services in the public sector. In the case where moonlighting is prohibited, the model is equivalent to a single server queue with exponential server vacations.
Keywords: Queueing, moonlighting, patient equilibrium behavior, healthcare policies.

Modeling the transplant waiting list for liver acceptance decisions.

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In the United States, patients in need of a liver transplant receive deceased-donor organ offers through joining a waiting list. Accepting or rejecting an offered organ is largely influenced by the patient's prospects for future offers, which can be ascertained most accurately by knowing the entire composition of the waiting list (WL). We present two stochastic models to help individual patients make optimal accept/reject decisions when faced with an offer. The first model uses perfect WL information, whereas the second model uses partially observable WL information as available in the current US system. In addition modeling novelties, we present structural analyses of these models to characterize the optimal decision rule along with a detailed numerical study investigating the impact of this imperfect information on patients' life expectancies.
Keywords: Markov decision processes, partially observable, Markov decision processes, value of information, medical decision making, Liver transplantation.

16:00 - 17:30 Sessions W5 and W6 in parallel

Session W6 - Amphi 7

Erlang arrivals joining the shortest queue.

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We consider a system in which customers join upon arrival the shortest of two single-server queues. The interarrival times between customers are Erlang distributed and the service times of both servers are exponentially distributed. Under these assumptions, this system gives rise to a Markov chain on a multi-layered quarter plane. For this Markov chain we derive the equilibrium distribution using the compensation approach. The obtained expression for the equilibrium distribution matches and refines heavy-traffic approximations and tail asymptotics obtained earlier in the literature.
Keywords: random walks in the quarter plane, compensation approach, join the shorter queue? tail asymptotics.

Analysis of GI/M/1 retrial queue with negative arrivals.

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Negative arrivals are used as a control mechanism in many telecommunication and computer network. The aim of this paper is to investigate the GI/M/1 retrial queue, i.e. any customer finding the server busy upon arrival must leave the service area and joins an orbit of unsatisfied customers. The inter-retials times are exponentially distributed. The inter-arrivals times are independent random variables. The service times are independend exponentially distributed for both primary and repeated calls. In the other hand, we consider a flow of negative arrivals under FCFS service descipline, the RCH removes one customer from the head of the orbit. For this analysis we consider the embedded Markov chain representing the number of customer as seen by the nth arrival of a (positive) primary customer. Necessary and sufficient condition of the ergodicity of this chain is investigated and some characteristics at the steady state of the system are obtained.
Keywords: GI/M/1 queueing system, retrial queues, negative arrivals, embedded Markov chain.

K competing queues with customer impatience: optimality of the mu-c rule by the Smoothed Rate Truncation principle.

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We consider a K competing queues system with additional customer impatience. Without impatience it is known that it is optimal to allocate the server to a queue according to the mu-c rule.
This system can be modelled as a Markov decision process with unbounded jump rates. So far there has been no systematic way to analyse MDP's with unbounded jump rates, because these systems are not uniformizable.
However, with the use of the newly developed technique Smoothed Rate Truncation, we are able to analyse this system. We prove that under some additional conditions the mu-c rule is still optimal. Numerical results show that if these conditions do not hold, then a threshold policy is optimal.
Keywords: competing queues, impatience, unbounded rates, smoothed rate, truncation, MDP's.

Description of the orbiting customers for the retrial queue with impatient batches.

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Retrial queuing systems are characterized by the requirement that customers finding the service area busy must join the retrial group and reply for service at random intervals. They have been widely used to model many practical problems in telephone switching systems, telecommunication networks and computers competing to gain service from a central processing unit, etc. [1]-[4].
In this paper, we consider a single server queue at which primary customers arrive in batches of size k (with probability c_{k}(t),k≥0 at time t) according to a Poisson stream with rate λ>0. Thus, C(z)=∑_{k=1}^{∞} c_{k}z^{k} is the generating function of the steady state distribution of the batch size and c=C′(1) is the mean batch size. If the server is busy at the arrival epoch, then with probability 1-H_1>0 all these customers leave the system without service and with probability H_1 join the retrial group (orbit); whereas if the server is idle, then one of the arriving customers begins his service and leaves the system after the service and the others go to the orbit. Any orbiting customer will repeatedly retry until the time at which he finds the server idle and starts his service. The retrial times are exponentially distributed with distribution function T(x)=1-e^{-θx},x≥0, having finite mean 1/θ. The service times follow a general distribution with distribution function B(x) and Laplace-Stieltjes transform B(s),Re(s)>0;β_{k}=(-1)^{k}B^{(k)}(0) be the k^{th} moment of the service time about the origin. The traffic intensity is defined as ρ=λc$H_1$$β_1$.
The state of the system at time t can be described by means of the process {C(t),N_0(t),ξ(t),t≥0}, where N_0(t) is the number of customers in the orbit, C(t) is the state of the server at time t. We have that C(t) is 0 or 1 depending on whether the server is idle or busy. If C(t)=1 , ξ(t) represents the elapsed service time of the customer in service at time t.

By using the method of supplementary variables, we find the partial generating functions of the steady state joint distribution of the server state and the number of customers in the retrial group. To complete the analysis of the considered model, we find the steady state distribution of the embedded Markov chain. Although the generating function of the steady state distribution of the number of customers in the retrial group can be obtained in explicit form, it is cumbersome and does not reveal the nature of the distribution in question. Therefore, we investigate the asymptotic behaviour of the random variable representing the number of customers in the retrial group under limit values of various parameters.
Keywords: M^{X}/G/1 retrial queue, impatient customers, heavy traffic, low retrial rate.

Thusday May 31th

09:00 - 10:00 - Amphi 1

Plenary talk
Rhonda Righter, *UC Berkeley, USA.*

Using Individuals to Understand System Optima.
Determining the structure, properties, and particular values of optimal policies for minimizing a global objective function in stochastic control problems, such as routing and scheduling problems, is often extremely difficult using standard approaches such as dynamic programming. On the other hand, individually optimal policies are often structurally obvious and easily computed. We discuss techniques for tying the two together to learn about socially optimal policies, and apply them to service centers (showing decreasing marginal returns to flexibility) and "green" scheduling (where costs include both holding costs and energy usage costs).

10:00 - 10:30

Coffee Break

10:30 - 12:30 Sessions T1 and T2 in parallel

Session T1 - Amphi 1

Communication leading to Coalition Nash equilibrium.
Takashi Matsuhisa, mathisa@ge.ibaraki-ct.ac.jp, Ibaraki National College of Technology, Japan.

The purpose of this paper is to introduce the concept of coalition Nash equilibrium of a strategic game, and to show that a communication among the players in a coalition leads to the equilibrium through messages. A coalition Nash equilibrium for a strategic game consists of (1) a subset S of players, (2) independent mixed strategies for each member of S, (3) the conjecture of the actions for the other players not in S with the condition that each member of S maximises his/her expected payoff according to the product of all mixed strategies for S and the other players' conjecture. It can be shown the existence of the equilibrium by the well-know method applying Kakutani fixed point theorem. However, this paper stands on the Bayesian point of view as follows: The players start with the same prior distribution on a state-space. In addition they have private information which is given by a partition of the state space. Each player in a coalition S predicts the other players' actions as the posterior of the others' actions given his/her information. He/she communicates privately their beliefs about the other players' actions through messages among all members in S according to the communication network in S, which message is information about his/her individual conjecture about the others' actions. The recipients update their belief by the messages. Precisely, at every stage each player communicates privately not only his/her belief about the others' actions but also his/her rationality as messages according to a protocol and then the recipient updates their private information and revises her/his prediction. In this circumstance, we can show that the predictions of the players in a coalition S regarding the future beliefs converge in the long run, which lead to a coalition Nash equilibrium for the strategic game.
Keywords: Bayesian game, belief revision, coalition nash equilibrium, communication, conjecture, knowledge.

Strategic Behavior In The Single Server Markovian Queue with Catastrophes: To Avoid or Follow the Crowd?

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Antonis Economou, aeconom@math.uoa.gr, University of Athens, Greece.

We consider a single-server Markovian queue with server failures, complete removals of customers and repair times. Failures of the server (catastrophes) occur according to a Poisson Process. Whenever a catastrophe occurs, all the customers are forced to abandon the system. The system is rendered inoperative and an exponential repair time process is set on. During the repair time the arrival process continues as usual. When the repair time is completed, the system behaves as an M/M/1 queue till the next catastrophe and so on. We assume that arriving customers decide whether to join the system or balk based on a natural reward-cost structure which incorporates their desire for service, their unwillingness both to wait and to be removed due to a failure as well as failure compensation. In fact, the role of the compensation is to mitigate customers' dissatisfaction
We examine customers' behavior under various levels of information regarding the system state. More specifically, a customer, at his arrival epoch and before making his decision, may be fully informed about the exact state of the system (state of server and number of present customers), partially informed or not informed at all. We derive equilibrium strategies for the customers under the various levels of information. We also treat the social maximization problem. Furthermore, we illustrate several qualitative aspects of the model and the behavior of the customers by presenting some numerical scenarios. Our objective is to study the effect of the information level on both the behavior of the customers and on the various performance measures of the system.
Keywords: Queueing, catastrophes, balking, nash equilibrium strategies, social optimization, follow vs avoid the crowd.

Equilibrium Strategies in Exercising Multiple Options for Expedited Service.

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We consider a queueing system with repeated customer arrivals and random environment. The state of the environment is observable and affects the arrival rate to the system. Customers belong to two classes. Those of the first class are delay sensitive and possess a number of options, valid for a fixed number of periods. At the time of arrival they observe the state of the environment and decide whether to join the regular queue or exercise one of their options and join a second queue available only to those who exercise options. The second class of customers always joins the regular queue with arrival rate depending on the environment state.
We model the option exercise problem as a multiperiod game between the option holding class. We derive the Nash equilibrium equations in a recursive form and show some threshold properties of the symmetric equilibrium exercise strategy. We also consider the problems of option pricing and social welfare optimization.
Keywords: Qeueuing, service options, customer equilibrium, random environment.

Quality Conscious Strategic Customers in Queues.

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In this paper, we explore imperfect quality service systems modeled as M/M/1 queues, having strategic customers. Strategic customers are rational and maximize their utility when making a choice between joining the queue or not. Customer utility is a function of service value and waiting time in the queue. We allow for the possibility of failed or unsatisfactory service, and model this as a given service quality level q: a customer receives satisfactory service with probability q, while with probability 1-q, she leaves the system unsatisfied. In a benchmark model we assume that this unsatisfied customer does not return to the system. We then consider a model where while a satisfied customer leaves the system, an unsatisfied one instantly returns to the system in order to seek successful service. Different assumptions about the way unsuccessful attempts are treated in the system are considered, where customers may revisit the same server or be

escalated to different servers. We compare individual and social optimization under both observable and unobservable queue length assumptions for these settings, and explore the role of quality and returning customers on earlier results in the literature. We then analyze the optimal pricing and quality level design problem of a profit maximizing firm.
Keywords: strategic customers, imperfect quality systems, individual and social optimization.

Strategic customer behavior in a transportation station.

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Athanasia Manou, athmanou@math.uoa.gr, University of Athens, Department of Mathematics, Section of Statistics and OR, Greece.

We consider a transportation station with infinite waiting space, where potential customers arrive according to a Poisson process. A transportation facility visits the station according to an renewal process that is independent from the arrival process of the customers. The successive capacities of the the transportation facility during its visits are independent, identically distributed random variables. Each time that the facility visits the station, it accomodates as many customers as it is possible according to its capacity (all of them if their number is smaller than or equal to its capacity). The customers that exceed its capacity abandon the station opting for an alternative facility.
We are interested in the strategic behavior of the customers, when they have the option to decide whether to join or balk. We assume that a customer receives a reward for using the facility, but also accumulates costs as he/she waits for it. We consider several levels of information at the decision instants and we obtain (mixed Nash) equilibrium customer strategies. Several qualitative issues regarding the behavior of the customers will be also discussed.
Keywords: Queueing, strategic customers, equilibrium strategies, transportation facility, stochastic clearing system.

10:30 - 12:30 Sessions T1 and T2 in parallel

Session T2 - Amphi 7

A cellular network model with Ginibre configurated base stations.

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Recently, stochastic geometry models for wireless networks have been attracting much attention. This is because the powers of received signals and interferences in such networks critically depend on the spatial configuration of wireless nodes and the irregularity of node configuration in a real network can be captured by the stochastic geometry models. For cellular networks, some works have also proposed the stochastic models, where the wireless base stations are randomly located on the plane, and have evaluated performance metrics such as the coverage probability, which is the probability that the signal-to-interference-plus-noise ratio (SINR) of a typical mobile user achieves a target threshold. However, most analyses of the wireless network models assume, due to its tractability, that the wireless nodes are located according to a homogeneous Poisson point process, which means that the spatial correlation is ignored and the locations of two wireless nodes can be too close. In this work, we consider a stochastic model of cellular networks, where the base stations are located according to the Ginibre point process. The Ginibre point process is one of determinantal point processes and accounts for the repulsion of base stations. For such a model, we derive some performance metrics such as the coverage probability. Although the obtained expressions are not closed form, they are computable by numerical integration. Furthermore, to capture a qualitative property, we investigate the asymptotics of coverage probability as the threshold SINR becomes large.
Keywords: Stochastic geometry, cellular networks, ginibre point process.

Fluid Limit of Spread on Network.

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The stochastic approximation method has been used to obtain mean field analysis as the fluid limit of large system of objects interacting each other. It is extended to study the fluid limit of spread on large networks. We show that, given sufficient divergence of the connectivity as the network grows, the resulted spread is converged and well-approximated by the mean-field fluid model.
Keywords: Mean field approximation, spread dynamics, stochastic approximation.

Studies on the properties of short term fairness provided by one-bit feedback fair scheduler.

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Since the utilization of multiuser diversity can increase the information theoretic capacity in wireless networks, much attention has been paid to packet schedulers exploiting multiuser diversity. It is, however, known that there exists a tradeoff between the capacity and fairness achieved by schedulers exploiting multiuser diversity. Among schedulers exploiting multiuser diversity, the one-bit feedback fair scheduler is considered as an attractive choice due to its good balance between the capacity and fairness and ease of implementation. In this study, considering the statistical time-access fairness index (STAFI) as a measure of short term fairness, we investigate the properties of short term fairness provided by the one-bit feedback fair scheduler. For this purpose, we present two numerical methods to analyze the STAFI of the one-bit feedback scheduler. The first method calculates the exact value of the STAFI by using the inverse discrete FFT method. The second method estimates the asymptotic decay rate of the STAFI by using the theory of large deviations. In this study, we focus on the impacts of the initial states of mobile stations (MSs) and the threshold value of the schedulers on the STAFI. Numerical results show that the initial states of MSs and the threshold value substantially affects the properties of the short term fairness provided by the scheduler.
Keywords: wireless networks, short term fairness, one-bit feedback fair scheduler, multiuser diversity.

Congestion Control of Flows in Internet Routers by Means of Index Policies.

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Josu Doncel, Universidad de Pais Vasco, Spain.
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In this work we address the problem of fast and fair transmission of flows in a router, which is a fundamental issue in networks like the Internet. We model the interaction between a TCP source and a bottleneck queue with the objective of designing optimal packet admission controls in the bottleneck queue. We focus on the relaxed version of the problem obtained by relaxing the fixed buffer capacity constraint that must be satisfied at all time epochs. The relaxation allows us to reduce the multi-flow problem into a family of single-flow problems, for which we can analyze both theoretically and numerically the existence of optimal control policies of special structure. In particular, we show that for a variety of parameters, TCP flows can be optimally controlled in routers by so-called index policies, but not always by threshold policies. We have also implemented index policies in Network Simulator-3 and tested in a simple topology their applicability in real networks. The simulation results show that the index policy has several desirable properties with respect to fairness and efficiency.
Keywords: congestion control, admission control, transmission control protocol (TCP), Markov decision processe, index policy.

Diffusion Limit for an Epidemic Information Dissemination Algorithm.

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Mine Caglar, mcaglar@ku.edu.tr, Koç University, Turkey.

Consider a network with n nodes that are all connected to each other. Initially k of the nodes are assumed to hold a piece of datum. In one dissemination step each of the nodes that hold the datum select c nodes randomly and transmit the datum to the selected nodes. We derive the asymptotic distribution of the number of new nodes that receive the datum as n and k go to infinity. We do this by represen-

ting the dissemination step as a random walk and by showing that under proper scaling this random walk converges weakly to a diffusion process.
Keywords: Network, random walk, diffusion process.

12:30 - 14:00
Lunch

14:00 - 15:30 Sessions T3 and T4 in parallel

Session T3 - Amphi 1

Joint Production and Order Admission Control in Two Stage Production Lines with Intermediate Product Demand.
Efstratios Ioannidis, efioan@dpem.tuc.gr, Technical University of Crete, Greece.

We consider a make-to-stock, two-stage, serial manufacturing system, producing items to satisfy demand of two customer classes. Demand of the first class customers is satisfied with products of the first stage, which are also used as input for the second stage. Orders of the second class customers are satisfied with the products of the second stage. Backordering is allowed only for the orders of the second class customers. The problem is to determine the production and order admission policies that minimize the average cost rate of the system. We investigate numerically the structure of the optimal production and order admission control policy. Based on this investigation a simple but efficient threshold type control policy is proposed. The system operating under the proposed policy is modeled as a Markov chain and an efficient methodology is presented for the estimation of the average cost rate function. From numerical results, it appears that the proposed approach of coordinated production and order admission control achieves a satisfactory performance in comparison to the optimal policy and to other traditional manufacturing practices.
Keywords: Production control, admission control, multiple demand classes, serial production systems, Markov decision processes.

Energy management in make-to-stock manufacturing lines with backordering.
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Our research is motivated by a new generation of energy management systems in industrial manufacturing. Energy costs can be significant in manufacturing, up to 30% in energy-intensive industries such as the cement or the paper industry. Typically, energy costs are convex in the consumption level and, therefore, reducing peak loads in manufacturing can significantly reduce overall energy spending. Energy management systems monitor energy consumption of each manufacturing step and control individual workstations if the consumption level is too high. We study the behavior and the optimal policy of these systems by modeling the control problem as a stochastic, pre-emptive make-to-stock line with backorder cost, holding cost, and convex energy cost. We use Markov Decision Processes and stochastic dynamic programming for our analysis. For the case of two single-server workstations without intermediate buffer and Blocking-after-Service scheme, we analyze second-order properties of the optimal value function and show that the optimal policy is of threshold-type. We study the underlying Markov chain of the optimal policy and compare the backorder level of the optimal policy with the backorder level of a "traditional" policy in which energy management is not employed. We use numerical experiments to demonstrate the value of energy management. Finally, we seek to extend some of our results to models with an intermediate buffer of arbitrary size.
Keywords: Make-to-stock systems, sustainable manufacturing, energy management, Markov decision processes, stochastic dynamic programming, tandem queues.

Exploring economies of scale for MTO production systems under lead time sensitive demand.

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We consider a make-to-order manufacturer which serves different customer classes. Customer classes differ in terms of the processing requirements, lead time and/or price sensitivities, and arrival rates. The problem is, on the one hand, how to maximize the total expected profit possibly under a constraint on the service level, and, on the other hand, how to extract an additional surplus that can be achieved through different production facilities. We consider that the manufacturer can utilize either production facilities dedicated to a single customer type, or flexible production facilities able to serve all customer types. Each dedicated production setting can be modeled as an M/M/1 queueing system where the demand is a function of price and lead-time. Similar, the flexible production setting can be modeled as a multi-class multi server queuing system (Mk/Mk/s) where demands of different customer classes are pooled into one queue and the global capacity is equivalent to the sum of dedicated production capacities. We introduce priority rules in order to offer differentiated services to different customer classes. The objective of this paper is to identify the range of parameters under which pooling will ensure benefits for all customer classes. Our preliminary results show that it is possible to exploit this flexibility to increase the global expected profit. We show that pooling can be disadvantageous for a customer class less sensitive to quoted lead time even for homogeneous service rates.
Keywords: make-to-order, due date and pricing problems, pooled vs. dedicated facilities, production policies, queueing.

Order Acceptance for Two Classes of Demand with Heterogeneous Lead Time.

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We consider an infinite horizon order acceptance problem with two classes of demands for a make-to-order manufacturer. One class of demand generates a higher profit but poses a stringent lead time, while the other class generates a lower profit but only require a loose lead time. In each period, random demands for both classes arrive, and the manufacturer needs to decide how much to accept for each class. We formulate the problem as a multi-dimension Stochastic Dynamic Programming (SDP). Since such a formulation suffer from the well-known "curse of dimension", we provide two heuristic approaches, namely, a threshold-based policy and a state reduction approach via partial state aggregation. The threshold-based policy has the merit of easy implementation and can be efficiently computed. The state reduction approach is particularly recommended when the state dimension of the SDP is large, and its efficiency can be strictly quantified through some proven bounds.
Keywords: Revenue management, stochastic dynamic programming, curse of dimension, heuristics.

14:00 - 15:30 Sessions T3 and T4 in parallel

Session T4 - Amphi 7

Perturbation bounds for the stationary distributions of Markov chains.

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In this talk, we will present some reuslts on perturbation bounds for the stationary distributions for discrete-time and continuous-time Markov chains on a countable state space. For discrete-time Markov chains, two new norm-wise bounds are obtained. The first bound is rater easy to be obtained since the needed condition, equivalent to uniform ergodicity, is imposed on the transition matrix directly. The second bound involves finding a drift function, which is related with the mean first hitting times. Some V-norm-wise bounds are also derived based on the results in Kartashov (1986). Moreover, we show how the bounds

developed in this paper and one bound given in Seneta (1988) can be extended to continuous-time Markov chains. Some queueing examples are shown to illustrate our results.
Keywords: Markov chains, uniform ergodicity, stationary distribution, perturbation theory, mean first hitting times.

The PH/PH/1 threshold queue - An application in highway traffic.

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We consider a single server queue with infinite capacity governed by two thresholds based on the queue length. These thresholds divide the queueing system into two subsystems, a lower and an upper subsystem. A switch from the lower to the upper subsystem occurs when the queue length reaches the upper threshold. At the lower threshold the queueing system switches back. Both the interarrival times and service times follow a Phase-Type distribution depending on the subsystems. This PH/PH/1 threshold queue can be seen as a Level-Dependent Quasi-Birth-and-Death process and we use matrix analytic methods to find the stationary queue length distribution and mean sojourn time.
We use this PH/PH/1 threshold queue to model highway traffic flows. We show that with this queueing system we can obtain the Fundamental Diagram, one of the key elements in highway traffic analysis. This Fundamental Diagram closely resembles emperical data.
Keywords: Traffic theory, matrix analytic method, threshold queue, hysteresis.

Reliability of a two class k-out-of-n system with repair.

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In this paper we study the reliability of a (k_1,k_2)-out-of-(n_1,n_2) system which consists of two different types of components with finite populations n_{i}, i=1,2, and a single repair machine. The life times of components of type i are exponentially distributed random variables with parameter λ_{i} and are all independent. Type i fails the moment the number of its functional components falls to k_{i}-1. The system operates under the (N_1,N_2)-policy i.e. the server is activated for exhaustive repairs as soon as the number of failed components in set i reaches N_{i}(1≤N_{i}≤n_{i}-k_{i}) for i=1,2. The repaired components are assumed to be as good as new. Repair times of components and life times are assumed to be independent of each other. The reliability of the system is computed for different modifications of the model and several other system characteristics are derived.
Keywords: k-out-of-n, system removable server, reliability.

Splitting Methods for Model Counting.

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Radislav Vaisman, Technion, Haifa, Israel.

We apply the splitting method to several well known counting and combinatorial optimization problems, like satisfiability, binary contingency tables, max-cut problem. We also show how to incorporate the classic capture-recapture method into the splitting algorithm in order to obtain a low variance estimator for the counting quantity representing, say the number of feasible solutions on the set of the constraints of an integer program. We finally present numerical results with both the decision making and the capture-recapture estimators and show the superiority of the latter.
Keywords: Model counting, splitting method, gibbs sampler, capture-recapture.

15:30 - 16:00

Coffee Break

16:00 - 17:30 Sessions T5 and T6 in parallel

Session T5 - Amphi 1

Call Center Routing Policy Using Call Waiting and Agent Idle Times.

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We study call routing policies commonly used in call centers with multiple call types and multiple agent groups. We propose a new weight-based routing policy where each pair (call type, agent group) is given a matching priority defined as an affine combination of the longest waiting time for that call type and the longest idle time in that agent group. The coefficients in this combination are parameters to be optimized. This type of policy is more flexible than traditional ones found in practice, and it performs better in many situations. We consider objective functions that account for the service levels, the abandonment ratios, and the fairness of occupancy across agent groups. We select the parameters of all considered policies via simulation-based optimization heuristics.
Keywords: call centers, simulation optimization, call routing.

Managing Operations in a Multichannel Call Center.

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Ger Koole, koole@few.vu.nl, VU University Amsterdam, The Netherlands.

We consider a call center with two tasks: calls and emails. A call has to be answered quasi-instantaneously, whereas an email can be backlogged for some hours. Inspired by the work of Bhulai and Koole (2003) on call blending, we propose a model to help a manager in managing agent idle times. Assuming that calls have priority over an infinite amount of emails, we investigate the question of when should an agent handle emails? There are two possibilities: between the treatment of two different calls, or during the treatment of a given call. This can be surprising but for technical calls, customers are usually asked during the call itself to do some tasks without any assistance from the agent (reboot the system, etc.). Those periods are then idle periods for the agent, which allows her to do another operation, i.e., emails. In this work, we investigate several questions that arise in this context: what is the impact of profiting from these natural idle periods on performance? To what extent is it appropriate to use these idle periods, since switching between the tasks would deteriorate quality and/or lengthen the treatment duration of calls and emails?
Keywords: Multitasks, call Center, imbricative tasks.

Structural Estimation of Callers' Delay Sensitivity in Call Centers.

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We model callers' decision making process in call centers as an optimal Stopping problem. After each period of waiting, a caller decides whether to abandon or to continue to wait. The utility of a caller is modeled as a function of her waiting cost and reward for service. We use a random-coffecients model to capture the heterogeneity of the callers and estimate the cost and reward parameters of the callers using the data of individual calls made to an Israeli call center. We also conduct a series of counterfactual analyses that explore the effects of changes in staffing or service discipline on resulting waiting times and abandonment rates. Our analysis reveals that modeling endogenous caller behavior can be important when major changes (such as a change in service discipline) are performed, and that using a model with an exogenously specified abandonment distribution may be misleading.
Keywords : Empirical analysis, structural estimation, call centers.

16:00 - 17:30 Sessions T5 and T6 in parallel

Session T6 - Amphi 7

Stochastic Modeling by Inhomogeneous Continuous Time Markov Chains.

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Homogeneous continuous time Markov chain (HCTMC), with the assumption of time-independent constant transition rates, is one of the most frequent applied methods for stochastic modeling. In realistic situations, with varying external factors influencing the transition processes, the transition rates can no longer be considered time-independent. Under these circumstances, the inhomogeneous CTMC (ICTMC) is more suited for modeling the stochastic processes. One drawback of ICTMC is that an analytical solution is difficult, if not impossible, to obtain. Then, one must resort to numerical approaches e.g. Monte Carlo simulation, uniformization, state-space enrichment, and numerical differential equation solvers. This presentation aims at comparing the methods, making reference to a simple but challenging case study.
Keywords: Inhomogeneous continuous time Markov chain, Runge-Kutta methods, uniformization, Monte Carlo simulation, state-space enrichment.

Markov Perfect Bayesian Equilibrium via Ergodicity.

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This paper provides existence conditions for geometrically ergodic and stationary Markov perfect Bayesian equilibria in a class of stochastic sequential games, and then exploits ergodicity to characterize the equilibria of these otherwise intractably complex games. In particular, we study a type of game where heterogeneous, incompletely in-formed players have two available actions, increasing or (weakly) decreasing the integer state. For example, o®ering goods for sale at a market increases market-wide stock; buying decreases that stock. Similarly, joining a queue lengthens it, unlike balking. Stationarity allows us to derive the invariant strategy of players ignorant of the state, without the need for dynamic programming. Applications of this technique include a microfoundation for market-clearing price adjustment.
Keywords: Stochastic games, sequential games, ergodicity, market games, Markov perfect Bayesian equilibrium.

Arrival Processes Based on SIR Models for Epidemic Diseases.

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Susceptible-Infected-Recovered (SIR) models are commonly used to analyse the spread of epidemic, pandemic and infectious diseases. These models characterize individuals of a population as susceptible, as infectious (after exposure to infection), or, after having recovered or died, as removed. Stochastic SIR models have been employed in work that aims at controlling the spread of disease through vaccination or contact tracing as well as in models that examine resource allocation at healthcare providers. In this paper, we try to shed some light on the arrival process of patients at a hospital due to an epidemic. We modify a Markovian SIR model by assuming that infected patients seek help at a hospital at an exponential rate. Interarrival times at the hospital can then be expressed as first passage times of a continuous time Markov chain. We present a recursive formulation for the calculation of the Laplace transforms for the interarrival times for the sequence of patients seeking help. This allows the closer study of arrival patterns at health care providers. We contrast these patterns with approaches currently used in staffing models that either assume a flat rate (i.e. Poisson process) or a bell shaped arrival rate function.
Keywords: SIR model, arrival process, health care.

On the use of phase type distributions for modeling of trust relationships

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Trust as an important variable, a level of it is present in every social interaction, has attracted considerable attention by scholars in various disciplines. Despite the vast amount of studies, the complexity of trust still remains unachieved. A feature of trust that has not been modeled yet is related to the fact that trust can catastrophically fall to distrust in each phase of its development. Through current research, using phase type distribution, it is tried to modeling trust incorporating this chaotic feature. In this paper, providing numerical examples for mutual and triplicate trust relationships in a supply chain, a framework is introduced to conduct further research in the modeling of trust relationships.

Keywords: Phase-type distributions, Markov chain, modeling trust relationships.

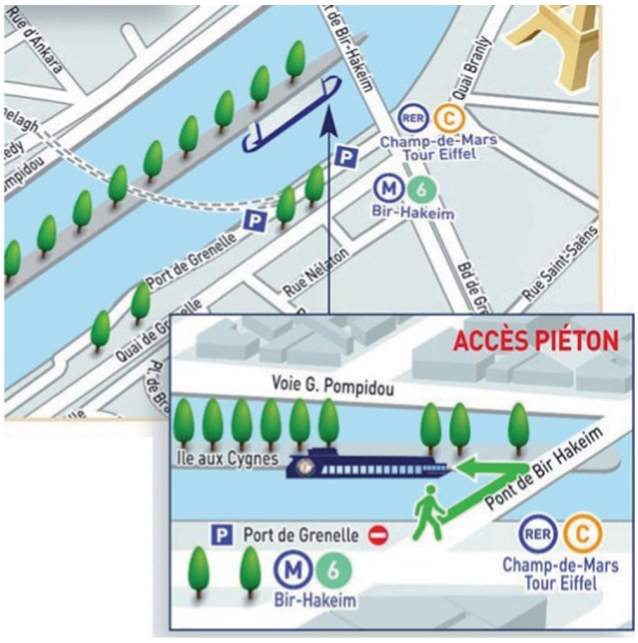
18:00

Gala Dinner

Departure from the main entrance of Ecole Centrale Paris.

It is a diner cruise on La Seine river provided by the company Capitaine Fracasse. The price is already included in your registration fee. We will take the bus at 6:00pm (from the main entrance of Ecole Centrale Paris) to go there. The boarding is at 9:00pm. We then have some free time (about 1h30) before boarding.

Access to the boat: The access to the boat restaurant is located in Paris (15th district) on Ile aux Cygnes, accessible from the bridge of Bir Hakeim, near 'Bir Hakeim' metro 6 station, or 'Champs de Mars-Tour Eiffel' RER C train station. The boarding port is Ile aux Cygnes. It is downstairs from the middle of the bridge of Bir Hakeim.



Friday June 1st

09:00 - 10:00 - Amphi 1

Plenary talk
Refeal Hassin, *Tel Aviv University, Israel.*

Rational Queueing.
Strategic queueing theory is a fast growing branch of research, starting with the work of Naor (1969). A strategic queueing model is a game whose input consists of economic functions like costs and utilities associated with the participating agents and its payoffs depend on the queue dynamics and in particular the waiting time distribution. Typically agents' decisions interact and the solution consists of equilibrium strategies. An introduction to this area, with a survey of literature appeared in a book by Hassin and Haviv (2003). However, the interest in strategic models has been increasing in a growing rate since then, and a rough estimate is that the number of relevant papers has been tripled during the last decade. This talk will introduce a rough classification of rational queueing models, focusing on some of the main contributions and introducing interesting qualitative results.

10:00 - 10:30

Coffee Break

10:30 - 12:30

Session F1 - Amphi 1

A Rate-Based Queueing Simulation Model of Open Source Software Debugging Activities.
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In the past decades, there is a rising trend of the open source technology as a new paradigm for software development, mainly because the open source software (OSS) approach is able to significantly reduce the development costs, and rapidly produce highly reliable software products attracting large number of end-users. Along with the wide-spreading of OSS in the modern society, the reliability of OSS products becomes an important issue for researchers and practitioners. By simulating the debugging process of the software life cycle, the rate-based queueing simulation model is a feasible approach for software reliability modeling. However, the debugging activities of the OSS projects are different in many interesting ways from those of closed source software (CSS) projects (e.g. in the OSS projects the end-users contribute to debugging process, considerably). Therefore, the traditional rate-based simulation approach applicable to the CSS projects needs to be calibrated for the OSS projects. To bridge this gap, we first analyze the differences in the debugging activities between OSS projects and CSS projects. Based on the analyses, we then propose a rate-based queueing simulation model for the OSS debugging activities with the considerations of the unique characteristics of OSS debugging. For the purpose of illustration, the proposed simulation model is applied onto a real data set collected from the Apache Software Foundation bug-tracking system. The simulation results indicate that the proposed simulation model effectively approximates the real scenarios. We also analyze the influences of the core contributor staffing levels onto OSS product reliability using the proposed model. The number of core contributors and the version-updating time are then optimized with respect to two objectives: minimizing debugging cost, and maximizing OSS reliability.
Keywords: queueing model, open source software, reliability modeling, debugging process.

Stochastic Modeling and Simulation of an Open-Pit Mine Truck-Shovel System.

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Adolfo Arata, aarata@mes.cl, Centro de Desarrollo de Gestión Empresarial S.A., Chile.

We propose a simulation modeling framework of an open-pit mine truck-shovel system considering the influence of the equipment Reliability, Availability and Maintainability (RAM) characteristics on the systemic productive capacity. The modeling framework can be used for allocating trucks by route according to their operating performances in an open-pit mine. We implement the framework on a real scenario of an open-pit mine.
Keywords: Open-pit mine, Truck-Shovel system, stochastic, simulation.

Simulating the impact of order smoothing on the performance of a supply chain with volatile demand and restrictive capacity.

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Based on an observation in the glove industry, we model a global supply chain with an Asian manufacturer and European distributors. The geographical distances among the SC members do not only generate long transportation time, but also affect the efficiency of information sharing. During recent economic recession, this global network faced extreme demand volatility and wild order fluctuations, and hardly any demand forecast technique is able to produce a reliable prediction. On the one hand, driven by the goal of reducing inventory costs, European distributors adopt a chasing strategy and pass all the demand variability to upstream. On the other hand, since the incoming orders are volatile in terms of quantity and frequency, the Asian manufacturer adopts the “first come first serve” capacity allocation policy to ensure high capacity utilization. Consequently, European distributors suffer from the stochastic replenishment lead time and poor service level. The objective of this paper is to model the strategic behaviors of the Asian manufacturer and European distributors, and evaluate the impact of those behaviors on the system performance. To be specific, we want to study how the European distributors can determine an appropriate safety stock and replenishment lead time by using order smoothing methods.
Keywords: stochastic modelling, order smoothing, “first come first serve” capacity allocation policy.

Buffer allocation in stochastic flow lines using sampling approaches.

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Several sampling approaches have been proposed to analyze stochastic flow lines with finite buffer capacities. If the number of buffers between the stations is given, the performance can be evaluated via a linear programming formulation. This work presents a mixed integer programming approach to optimize the buffer allocation in flow lines with stochastic processing times. The objective is to minimize the overall number of buffer spaces reaching a goal production rate. The basic idea is to solve a huge but simple linear model of an entire simulation run by sampling the processing times. A numerical study is carried out in order to compare the performance of different standard solvers. Furthermore different sampling approaches are discussed to compare the robustness of the system regarding the sample sizes.
Keywords: Buffer allocation, stochastic flow lines, sampling approaches.

A New Perspective on Feasibility Determination.

Roberto Szechtman, rszechtm@nps.edu, Naval Postgraduate School, USA.
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We consider the problem of feasibility determination in a stochastic setting. In particular, we wish to determine whether a system belongs to a given set Gamma in R^d based on a performance measure estimated through Monte Carlo simulation. Our contribution is two-fold: (i) we characterize fractional allocations that are asymptotically optimal; and (ii) we provide an easily implementable algorithm, rooted in stochastic approximation theory, that results in sampling allocations that provably achieve in the limit the same performance as the optimal allocations. The nite-time behavior of the algorithm is also illustrated through numerical examples.
Keywords: large deviations, feasibility determination, ranking and selection, simulation optimization.

12:30 - 14:00

Lunch

14:00 - 15:30

Session F2 - Amphi 1

Markov population decision chains with constant risk posture.

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Many decision problems involve populations, e.g., management of animal populations, crops or forests, control of the spread of an infectious disease, and government decisions such as taxation, demographic planning, education, health services and criminal justice systems. In the presence of uncertainty, policy makers, particularly those who make decisions concerning populations aim not only at maximizing revenues, but also at avoiding undesirable fluctuations. Most often, there are tradeoffs between the expected value and the variability of revenues; therefore, expected-revenue criterion fails to reflect the decision maker's preferences. The purpose of this work is to formulate and efficiently solve stochastic problems involving populations via Markov population decision chains with constant risk posture.
Keywords: Markov decision chains, stochastic control, Markov population decision chains, constant risk posture, dynamic programming.

Flexible staffing for call centers with non-stationary arrival rates.

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We consider a multi-period staffing problem of a single-skill call center. The call center is modeled as a multi-server queue in which the staffing levels can be changed only at specific moments in time. The objective is to set the staffing levels such that a service level constraint is met in the presence of time-varying arrival rates. We develop a Markov decision model to obtain time-dependent staffing levels for both the case where the arrival rate function is known as well as unknown. The characteristics of the optimal policies associated to the two cases are illustrated through a numerical study based on real-life data. We show that the optimal policies provide a good balance between meeting the service level and the number of periods in which the staffing levels can be changed.
Keywords: call centers, Markov decision processes, staffing, time-varying arrival rates.

Dynamic control of a multi class G/M/1+M queue with abandonments.

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We address the problem of dynamically scheduling jobs with abandonments. Execution times and abandonment times are exponentially distributed. Release dates can be arbitrarily distributed. We consider either holding costs or abandonment costs. We provide simple conditions under which strict priority rules are optimal and a numerical study of the problem.
Keywords: Queueing systems, abandonments, priority rule.

On Markov Decision Processes with Chance Constraints.

Erim Kardes, erim.kardes@ozyegin.edu.tr, Ozyegin University, Turkey.

The focus of this paper is on constrained Markov decision processes with payoff uncertainty. A chance-constrained approach is presented to address this uncertainty, considering both the discounted and the limiting average performance criteria. Using occupation measures, it is shown that when the distribution over the unknown payoffs is multi-variate Gaussian, optimal stationary policies can be computed via a convex second order cone program, which can efficiently be solved using polynomial time algorithms. The Gaussian assumption can be relaxed to include a wider class of densities with a radial behavior. The proposed method is used in a discrete-time admission control problem where delay is minimized subject to a lower-bound constraint on rewards generated in the system.
Keywords: Constrained Markov decision processes, chance constraints, admission control.

15:30

End of conference.

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